A Coded Wire Tag Assessment of Salmon River (Langley) Coho Salmon: 1993 Tag Application and 1994-1995 Spawner Enumeration

M. K. Farwell, R. E. Diewert, L. W. Kalnin, R. Semple,
L. C. Walthers, and J. R. Irvine

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9R 5K6

2000

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2523

Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 901-1425 were issued as Manuscript Reports of the Fisheries Research Board of Canada. Numbers 1426-1550 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les siences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés a titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada.. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2523

2000

A CODED WIRE TAG ASSESSMENT OF SALMON RIVER (LANGLEY) COHO SALMON: 1993 TAG APPLICATION AND 1994-1995 SPAWNER ENUMERATION

by

M. K. Farwell[1], R. E. Diewert[2], L. W. Kalnin[2], R. Semple[2], L. C. Walthers[3], and J. R. Irvine

Fisheries and Oceans Canada

Science Branch, Pacific Region

Pacific Biological Station

Nanaimo, British Columbia

V9R 5K6

[1] C.17, Cottonwood Site
Rural Route No. 1
Lone Butte, British Columbia V0K 1X0

[2] Fisheries and Oceans Canada
Stock Assessment Division, Fraser River Interior Office
100 Annacis Parkway
Delta, British Columbia V3M 6A2

[3]StreamLine Research
184 Black Powder Trail
Nanaimo, British Columbia V9S 5G9

© Minister of Public Works and Government Services Canada 2000

Cat. No. Fs 97-4/2523E ISSN 0706-6473

Correct citation for this publication:

Farwell, M. K., R. E. Diewert, L. W. Kalnin, R. Semple, L. C. Walthers, and J. R. Irvine. 2000. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1993 tag application and 1994-1995 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2523: 38 p.

TABLE OF CONTENTS

Page

ABSTRACT viii

RÉSUMÉ viii

INTRODUCTION 1

STUDY AREA 1

FIELD METHODS 1

SMOLT CAPTURE 1

CODED WIRE TAGGING (CWT) 2

SMOLT TRANSPORT 2

SMOLT SAMPLING 2

ADULT CAPTURE 2

SPAWNING GROUND SURVEYS 3

ANALYTIC PROCEDURES 3

TESTS FOR SAMPLING SELECTIVITY 3

Period 3

Location 3

Fish Size 4

Fish Sex 4

Other Tests 4

ESTIMATION OF SPAWNER POPULATION 4

Total Escapement 4

Sex Identification Correction 5

Adipose Fin Clipped Escapement 6

Coded Wire Tagged Escapement 7

HARVEST SAMPLING 7

RESULTS 7

SMOLT CAPTURE 7

CODED WIRE TAG APPLICATION 7

COHO SMOLT AGE AND SIZE 7

DISK TAG APPLICATION 8

SPAWNING GROUND RECOVERY 8

Age, Length and Sex 8

Coded Wire Tag Recoveries 9

TABLE OF CONTENTS (cont'd)

Page

SAMPLING SELECTIVITY 9
Period 9
Location 9
Fish Size 10
Fish Sex 10
Spawning Success 10
ESTIMATION OF SPAWNER POPULATION 10
Total Escapement 10
Adipose Fin Clips and Coded Wire Tags 10
DISCUSSION 11
PROGRAM EFFECTIVENESS 11
MARK-RECAPTURE STUDY 11
STOCK STATUS 12
SUMMARY 12
ACKNOWLEDGEMENTS 13
REFERENCES 14
TABLES 16
FIGURES 21
APPENDICES 25

LIST OF TABLES

Page

Table 1. Disk tag application, carcass examination and mark recovery, by sex, of Salmon River system coho adults, 1994-1995. 16

Table 2. Disk tag application and recovery of Salmon River system coho adults, by release condition, 1994-1995. 16

Table 3. Incidence of disk tags or secondary marks in coho adults recovered on the Salmon River system spawning grounds, by recovery period and sex, 1994-1995. 16

Table 5. Proportion of the Salmon River system coho adult spawning ground recovery sample marked with disk tags or secondary marks, by recovery section and sex, 1994-1995. 17

Table 6. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application section and sex, 1994-1995. 17

Table 7. Proportion of the Salmon River system coho adult disk tag application sample recovered on the spawning grounds, by 10 cm increments of nose-fork length and sex, 1994-1995. 18

Table 8. Sex composition of Salmon River system coho adults in the disk tag application and spawning ground recovery samples, 1994-1995. 18

Table 9. Results of the statistical tests for bias in the 1994-1995 Salmon River system coho adult escapement estimation study. 18

Table 10. Escapement estimates and 95% confidence limits, by sex and age, for Salmon River system coho adults, 1994-1995. 19

Table 11. Smolt releases, adult escapement and survival to adult escapement, by location and CWT code, of 1991 brood Salmon River system coho salmon. 19

Table 12. Trends in smolt production, smolt-to-adult survival, exploitation rate and escapement of coded wire tagged 1984-1991 brood Salmon River system coho salmon. . 20

Table 13. Program effectiveness as indicated by the capture, marking, and recapture of adult coho in the Salmon River system, 1987-1988 through 1994-1995. 20

LIST OF FIGURES

Page

Fig. 1. The Salmon River and Coghlan Creek showing reach locations. 21

Fig. 2. Trends in adult escapement, smolt production, exploitation rate and smolt-to-adult survival, by brood year, in 1984-1991 brood Salmon River system coho salmon. 23

LIST OF APPENDICES

Page

Appendix 1a. Daily enumeration of downstream migrants, by species, at the Salmon River fence trap, 1993. 25

Appendix 1b. Daily enumeration of downstream migrants, by species, at the Coghlan Creek fence trap, 1993. 26

Appendix 2a. Application of coded wire tags, by code and date, to Salmon River coho salmon smolts, 1993. 27

Appendix 2b. Application of coded wire tags, by code and date, to Coghlan Creek coho salmon smolts, 1993. 28

Appendix 3. Anomalies encountered while coded wire tagging wild Salmon River system coho salmon smolts, 1993. 29

Appendix 4. Mean length and weight, by location and date, of coho salmon smolts in the Salmon River system, 1993. 29

Appendix 5a. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in the Salmon River, 1994-1995. 30

Appendix 5b. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in Coghlan Creek, 1994-1995. 31

Appendix 6. Disk tag and secondary mark recoveries, by application and recovery date and location, size, sex, adipose fin status and disk tag number, of coho salmon adults released in the Salmon River system, 1994-1995. 32

Appendix 7a. Daily coho carcass recoveries, by reach, mark status and sex, in the Salmon River, 1994-1995. 33

Appendix 7b. Daily coho carcass recoveries, by reach, mark status and sex, in the Coghlan Creek, 1994-1995. 40

Appendix 8. Proportion at age and mean length at age, by location, AFC status and sex, of coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995. 35

Appendix 9. AFC and CWT sampling of coho salmon recovered on the Salmon River system spawning grounds, 1994-1995. 36

Appendix 10. Incidence of CWT loss, by carcass condition, eye status, and AFC condition, in AFC coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995. 37

LIST OF APPENDICES (cont'd)

Page

Appendix 11. Spawning success in female coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995..... 37

Appendix 12. Estimated coded wire tag (CWT) catch recovery of 1991 brood year coho in 1994 (only), from CWT'd coho smolts released in the Salmon River Langley system..... 38

ABSTRACT

Farwell, M. K., R. E. Diewert, L. W. Kalnin, R. Semple, L. C. Walthers, and J. R. Irvine. 2000. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1993 tag application and 1994-1995 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2523: 38 p.

In the spring of 1993, an estimated 15,611 (corrected for 7.0% long-term tag loss) coho smolts were released with coded wire tags at an average size of 96.9 mm and 8.7 g. The adult escapement was estimated in fall and winter of 1994-1995 using the Petersen mark-recapture method. Escapement was estimated at 1,941 coho adults of which 523 had coded wire tags and 40 had lost the coded wire tag. Smolt to adult survival was ~9.7% and the fishery exploitation (i.e. catch and escapement) was ~66%.

Escapement progressively declined over the 1987-1992, from 11,947 in 1987 to 2,604 in 1992. In 1993, escapement increased to 5,913; however, the 1994 escapement declined to 1,941 and is the lowest in the 8-year period of record.

RÉSUMÉ

Farwell, M. K., R. E. Diewert, L. W. Kalnin, R. Semple, L. C. Walthers, and J. R. Irvine. 2000. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1993 tag application and 1994-1995 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2523: 38 p.

Au printemps de 1993, 15 611 smolts de coho (estimation avec correction de 7,0 % pour la perte de marques sur le long terme) marqués avec des micromarques codées ont été libérés à une taille moyenne de 96,9 mm et 8,7 g. On a calculé l'échappée d'adultes à l'automne et l'hiver 1994-1995 par la méthode de marquage-recapture de Petersen. On a estimé l'échappée à 1 941 cohos adultes, dont 523 portaient des micromarques codées et 40 avaient perdu leur micromarque. Le taux de survie du smolt à l'adulte était de ~ 9,7 %, et le taux d'exploitation par la pêche (capture et échappée) était de ~ 66 %.

L'échappée a baissé progressivement pendant la période 1987-1992, passant de 11 947 en 1987 à 2 604 en 1992. En 1993, elle a remonté à 5 913; toutefois, l'échappée de 1994 est tombée à 1 941, et c'est la plus basse des 8 années d'étude.

INTRODUCTION

In 1986, the Department of Fisheries and Oceans implemented a plan to improve coho salmon (*Oncorhynchus kisutch*) assessment data through the long-term evaluation of several indicator stocks. The Salmon River in the lower Fraser River was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution, and exploitation rate. This report documents, for the 1991 brood, the 1993 smolt coded wire tag (CWT) application and the 1994-1995 adult escapement estimation studies. Previous reports documented the evaluation of the 1984-1990 brood years (Schubert and Kalnin 1990; Farwell *et al.* 1991, 1992a, 1992b; Kalnin and Schubert 1991; Schubert *et al.* 1994a, 1994b). This report describes the field methods, analytic techniques and study results, including smolt timing, age and size as well as adult age, length, sex, adipose fin clip (AFC) incidence, escapement estimates and long-term CWT loss. The study did not estimate the escapement of precocious males (jacks). This report includes a discussion of data limitations and a synthesis of study results for the 1984-1991 brood years.

STUDY AREA

The Salmon River flows northwest for 33 km, entering the Fraser River west of Fort Langley, B.C. (Fig. 1). Coghlan Creek, the principal tributary, joins the mainstem 14 km upstream from the Fraser River. The Salmon River system, with an average annual discharge of 1.41 $m^3 \cdot s^{-1}$ (Environment Canada 1980), drains 85 km^2 of agricultural and residential land. During the Fraser River spring freshet, the Salmon River flows through a pumphouse located at the river mouth. Because no provisions were made for fish passage, up to 31% of the coho smolts are killed as they pass through the pumps (Russell unpublished manuscript, 1981). The study area was divided into ten reaches, five in the Salmon River and five in Coghlan Creek (Fig. 1). Reaches were established to accommodate statistical tests for bias rather than on the basis of homogeneity of physical characteristics. In most study reaches, the river flows across low gradient terrain in a shaded, meandering channel with a gravel substrate. The only exceptions are reaches C5 and S5 where the river is marshy and summer flows are low.

FIELD METHODS

SMOLT CAPTURE

Fence traps similar to those described by Schubert (1982) operated in the Salmon River (30 m above the Coghlan Creek confluence) and in Coghlan Creek (30 m above the Salmon River confluence) from April 16 to May 31, 1993. Captured fish were enumerated at least once daily. Coho smolts were transferred to holding boxes or to the tagging site for tagging and sampling. Coho fry were not enumerated because the 6 mm fence mesh did not fully restrict their passage. The remaining catch was identified to species and released below the fence. Steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*) were recorded as smolt or pre-smolt. Trout

smolts had a silver coloration and nose-fork (NF) length greater than 110 mm. Pre-smolts had distinct parr marks and a length of less than 110 mm.

CODED WIRE TAGGING (CWT)

Coded wire tagging occurred from April 21 to May 31, 1993 at intervals of one to four days. The smolts were anaesthetized with Tricaine Methane Sulfonate (TMS), marked by adipose fin removal, coded wire tagged and passed through a quality control device to ensure the CWT was present. Any diseased, damaged or undersize (NF length less than 55 mm) smolts were released untagged. A sample of approximately 200 smolts was removed from the recovery bucket and retained for 24 hours to assess AFC quality, delayed mortality and CWT loss. Any smolt without a CWT or with a poor AFC was retagged or reclipped.

SMOLT TRANSPORT

To avoid pump mortality, coho smolts were transported to and released in the Fraser River at the Salmon / Fraser confluence, either immediately after tagging or in the morning when water temperatures were lower. Smolts were transported in a 180 litre plastic container supplied with air from a 12 volt air pump. Transport required less than 15 minutes.

SMOLT SAMPLING

A total of 50 coho smolts per site were sampled twice weekly for scales, length and weight. The smolts were anaesthetized with TMS, a scale smear was removed with a scalpel from each side of the fish, NF length was measured to the nearest millimetre, and mean wet weight (±0.1 g) was determined in aggregate using a triple beam balance.

ADULT CAPTURE

Coho adults were captured in reaches S1 to S5 and C1 to C5 (Fig. 1) from October 28 to December 21, 1994. Coho were attracted from log jams and cut banks with a Smith Root Model 12 $^{\circ}$ 24-volt direct current electroshocker. Voltage, amperage, pulse width and frequency were adjusted daily to minimize visible damage (body bruising) while providing sufficient torpor to permit capture. Shocked coho adults (NF length greater than 30 cm) were captured in a dip net, permitted to recover in a 60 litre container of water, marked and released.

Coho adults were marked with Petersen disk tags in a wooden tray (10 cm x 10 cm x 100 cm) constructed with a flexible plastic bottom and a metre stick recessed in one side. The tags consisted of two 22 mm diameter laminated cellulose acetate disks and one 7 mm diameter transparent plastic buffer disk threaded through centrally punched holes onto a 77 mm long nickel pin. The pin was inserted with pliers through the musculature and pterygiophore bones approximately 12 mm below the anterior portion of the dorsal fin insertion. The disk tags, arranged with one on each side of the fish and with a buffer disk on the pinhead side, were secured by twisting the pin into a double knot. One disk per pair was numbered with

a unique code. Green tags were used to reduce colour contrast, thereby minimizing recovery and predation biases. Each tagged fish received a secondary mark, a 7 mm diameter hole punched through the right operculum using a single hole paper punch, to allow the estimation of tag loss. Males and females received one and two punches, respectively, to permit the estimation of sex identification error. Care was taken to avoid gill tissue damage. Date and location (reach) of capture, disk tag number, NF length (± 0.5 cm), sex and adipose fin status were recorded for each fish released with a disk tag. Activity at release was recorded as 1 (swam away vigorously), 2 (swam away sluggishly) or 3 (required ventilation). Electroshocker bruising to the body was recorded as 0 (none), 1 (faint bruise), 2 (bruise up to 25 mm in diameter), 3 (bruise over 25 mm in diameter). Recovered disk tagged carcasses were enumerated and sampled (described below) to assess handling mortality.

SPAWNING GROUND SURVEYS

The spawning grounds were surveyed weekly from November 25, 1994 to January 20, 1995. Complete surveys, conducted by a two to four person crew walking upstream, required up to two days. Live adults were counted and carcasses were recorded by date, reach, sex (confirmed by abdominal incision) and mark type (disk tag, secondary mark or AFC). Each marked carcass and every tenth unmarked carcass was sampled. All carcasses were then cut in two with a machete and returned to the river. Sample data, recorded by date and reach, included post-orbital-hypural plate (POH) length (to the nearest 0.1 cm), sex, female spawning success (0%, 50% or 100% spawned), adipose fin and carcass condition, and scale samples. For AFC coho, the head was removed posterior to the eye orbit for later CWT identification. Adipose fin condition was recorded as unclipped, complete (flush with dorsal surface), partial (nub present) or questionable (appeared clipped but fungus or decomposition obscured the area). The condition of AFC carcasses was recorded as fresh (gills red or mottled), moderately fresh (gills white, body firm), moderately rotten (body intact, flesh soft) or rotten (skin and bones), and the absence of one or both eyes was noted.

ANALYTIC PROCEDURES

TESTS FOR SAMPLING SELECTIVITY

Period

Temporal bias was assessed using a chi-square test (Sokal and Rohlf 1981). Application bias was examined by comparing among periods the mark incidence in the recovery sample, where mark incidence was the proportion of the coho adults marked with either a disk tag or a secondary mark. Recovery bias was examined by stratifying the application sample by period and comparing proportions recovered.

Location

Spatial bias was similarly assessed in the application sample by comparing among sections the mark incidence in the recovery sample. Recovery bias was examined by stratifying the application sample by section and comparing the proportions recovered.

Fish Size

Size related bias was assessed using the Kolmogorov-Smirnov two-sample test (Sokal and Rohlf 1981). Application bias was examined by comparing the POH length-frequency distributions of marked and unmarked spawning ground recoveries. Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the NF length-frequency distributions of each.

Fish Sex

Sex related bias was assessed using chi-square tests. Application bias was examined by comparing the sex ratio of the marked and unmarked spawning ground recoveries. Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the sex composition in each.

Other Tests

Bias resulting from tagging stress was also assessed using chi-square tests as above. The application sample was partitioned into those fish that required ventilation at release and those which did not, and those with electroshocker bruising at release and those with none. Recovery rates were compared in each group. As well, spawning success was compared in marked and unmarked spawning ground recoveries.

ESTIMATION OF SPAWNER POPULATION

Total Escapement

The 1994-1995 escapement of Salmon River coho adults was calculated from the mark-recapture data using the Petersen formula (Chapman modification) (Ricker 1975). Total escapement was the sum of escapement by sex:

1) Estimated coho escapement for each system (N_t):

$$N_t = N_m + N_f$$

where:

N_m = estimated escapement of adult males;

$$= \frac{(M_m + 1)(C_m + 1)}{(R_m + 1)}$$

N_f = estimated escapement of females, analogous to above.

2) Estimated 95% confidence limits of N_t:

$$N_t \pm 1.96\sqrt{v_t}$$

where:

v_t = variance of the escapement estimate;

= $v_m + v_f$

v_m = variance of the adult male escapement estimate;

$$= \frac{(N_m^2)(C_m - R_m)}{(C_m + 1)(R_m + 2)}$$

C_m = number of adult male carcasses examined for disk tags;

R_m = number of disk tagged/secondary marked adult males recovered; and

v_f = variance of female escapement estimate, analogous to above.

Sex Identification Correction

The tag application data were corrected for sex identification errors. Errors sometimes occurred because the development of sexually dimorphic traits was often not advanced and internal examinations could not be made. The correction of the recovery data was unnecessary because all carcasses were incised and examined internally. Sex identification errors were corrected as described by Staley (1990):

3) Estimated true number of males released with disk tags and secondary marks (M_m):

$$M_m = \frac{M_m^* - (M_t R_{m,f}) / R_f}{1 - (R_{m,f} / R_f) - (R_{f,m} / R_m)}$$

where:

M_m^* = field estimate of number of males released with disk tags and secondary marks;

M_t = total number of coho adults released with disk tags and secondary marks;

$R_{m,f}$ = number of females recovered with disk tags which were released as males;

R_f = number of females recovered with disk tags;

R_m = number of males recovered with disk tags.

4) Estimated true number of females released with disk tags and secondary marks (M_f):

$$M_f = M_t - M_m$$

Adipose Fin Clipped Escapement

We estimated the AFC escapement from the AFC incidence in the carcass recovery sample, the largest of the two available samples. The AFC incidences in the Salmon River and Coghlan Creek were first tested for significant differences using a chi-square test. If no difference was noted, the AFC escapement was the product of the pooled AFC incidence and the mark-recapture escapement estimate. Ninety-five percent confidence limits were calculated from the respective upper and lower confidence limits of the AFC incidence and the escapement estimate. For example, the upper 95% confidence limit of the AFC escapement estimate was the product of the upper limit of the AFC incidence and the upper limit of the total mark-recapture estimate. The mathematical relationships are reported below (Cochran 1977):

5) Estimated AFC escapement (N_a):

$$N_a = p(N_t)$$

6) Ninety-five percent confidence limits for p:

$$p \pm (1.96se + fpc)$$

where:

p = sample proportion with an AFC;

se = standard error;

$$= \sqrt{(1-f)pq/(n-1)}$$

fpc = finite population correction;

$$= \frac{1}{2n}$$

n = sample size;

$$q = 1 - p$$

$$f = \frac{n}{N_t}$$

If the Salmon River and Coghlan Creek AFC incidences differed, then the AFC escapement estimate was the product of the stream specific total escapement, the stream-specific AFC incidence, and the pooled CWT retention level. Total escapement by stream was calculated by applying the ratio of the stream-specific Schaefer estimates to the Petersen estimate. Confidence limits are not to be reported for the AFC escapement using this method.

Coded Wire Tagged Escapement

Escapement by CWT code and long-term CWT loss were calculated by applying the CWT composition in the carcass recovery sample to the estimated escapement of AFC adults. Apparent CWT loss was adjusted for post-mortality loss resulting from carcass decomposition and predator activity, where appropriate.

HARVEST SAMPLING

This report provides estimates of total CWT harvest for the 1984-1991 brood years. The harvest data were obtained from the regional mark recovery program database (Kuhn *et al.* 1988) and were treated for sampling problems as described by Schubert *et al.* (1994).

RESULTS

SMOLT CAPTURE

The catch of coho smolts totalled 18,042 in 1993; 11,732 in Salmon River and 6,310 in Coghlan Creek (Appendix 1). The 50% migration and the peak daily catch occurred on May 12 in the Salmon River and on May 7 in Coghlan Creek. High discharges rendered the traps inoperable for three days (April 27, 28 and May 3) in the Salmon River and two days (April 26 and 28) in Coghlan Creek. The reported timing of the 1993 smolt migration, therefore, may be somewhat biased.

CODED WIRE TAG APPLICATION

AFC and CWT releases totalled 17,508 coho smolts in 1993 (Appendix 2). When adjusted for long-term CWT loss (7.0%) (Appendix 9) and short-term (24-hour) post tagging mortality (Appendix 2), the number released with CWTs and identifiable AFCs was 15,611. Short-term CWT loss averaged 3.2% (range 0.0% to 19.0%) (Appendix 2). The incidence of disease, damage, or structural anomalies averaged 12.3% (Appendix 3). The most prevalent condition was fog eye (10.3%), a reversible condition associated with capture stress. No naturally missing adipose fins were observed.

COHO SMOLT AGE AND SIZE

Of the smolts sampled emigrating from the Salmon River system, 95.7% were age 1+ and 4.3% were age 2+. Smolt size averaged 97.3 mm and 8.9 g in the Salmon River and 96.4 mm and 8.2 g in Coghlan Creek (Appendix 4). Weighted mean smolt size was 96.9 mm and 8.7 g. Smolt size peaked in the early portion of the migration period.

DISK TAG APPLICATION

Disk tags and secondary marks were applied to 169 coho adults in the Salmon River system from October 28 to December 21, 1994 (Appendix 5); 30 (6.1%) had an AFC. A total of 133 tags (78.7%) were applied in the Salmon River and 36 (21.3%) in Coghlan Creek; most were released in reaches S1 (27%), S3 (22%) and S2 (13%).

Of the tagged fish 12 (7.1%) required ventilation at release. The proportion of this group recovered (16.7%) was not significantly different ($p > 0.05$; chi-square) from the remaining fish (17.2%) (Table 2). Electrochocker bruising was noted in 78 fish (46.2%) (Table 2). The proportion of this group recovered (11.5%) was significantly lower ($p < 0.05$; chi-square) than the unbruised group (21.1%) (Table 2). Consequently, the bruised group of fish was removed from the application sample while the ventilated group was not removed.

None of the females or males were misidentified at the time of tagging (Appendix 6). Therefore, no adjustment was required for sex identification errors. Forty-four (48.4%) males and 47 (51.6%) females were released with disk tags and secondary marks (Table 1).

The mean NF length of females (56.7 cm) was not significantly different ($p > 0.05$; ANOVA) than that of males (55.8 cm) and, in both sexes, fish with AFCs (males 56.9 cm, females 58.2 cm) were larger than unmarked fish (males 55.4 cm, females 56.5 cm). These differences were not significant ($p > 0.05$).

In 1994-1995, no previously tagged fish were recaptured in later capture efforts.

SPAWNING GROUND RECOVERY

A total of 489 adults and 3 jacks were recovered on the spawning grounds from November 25, 1994 to January 20, 1995 (Table 1; Appendix 7). Of the tagged adults 9 showed bruising at time of release. Of the remaining 480 adults, 231 (48.1%) were male and 243 (50.6%) were female and 6 (1.3%) were not identified by sex; 139 (29.0%) of the adults had an AFC, 20 (4.2%) had a disk tag and secondary mark, 1 (0.2%) had no secondary mark and 1 (0.2%) had lost a disk tag. The proportion of disk tags recovered in females (29.8%) and males (18.2%) was not significantly different ($p > 0.05$; chi-square). The proportion of disk tagged fish which were recovered was not significantly different ($p > 0.05$; chi-square) in those with AFCs (25.0%) than those without and AFC (21.3%).

The distribution of carcass recoveries was 292 adults (60.8%) in the Salmon River and 188 (39.2%) in Coghlan Creek (Table 5). Most were recovered in the upper reaches of both streams.

Age, Length and Sex

The age and length of the 1994-1995 spawning ground recoveries are reported in Appendix 8. Age 3_2 fish comprised 99.4% of the adult females and 97.7% of the males. No difference in age composition was noted between streams or by AFC status ($p > 0.05$; chi-square). The mean POH length of males (47.0 cm) was not significantly larger ($p > 0.05$; ANOVA) than that of females (45.6 cm). In both sexes, fish with AFCs (males 46.6 cm,

females 44.4 cm) were smaller than unmarked fish (males 47.0 cm, females 46.0 cm); however, the difference was not significant ($p > 0.05$; ANOVA).

Coded Wire Tag Recoveries

A total of 66 adult males and 70 females were recovered with an AFC, an incidence of 29.4% and 28.8%, respectively. The AFC incidence was not significantly different ($p > 0.05$; chi-squared) between streams or sexes (Appendix 9). CWTs were recovered from 47 adult males and 47 adult females; all were 1991 brood Salmon River system coho. There was a significant difference ($p < 0.05$; chi-square) in the spatial distribution of the CWT codes. Recoveries in the Salmon River were largely (88%) of Salmon River origin, while those in Coghlan Creek were largely (69%) of Coghlan Creek origin (Appendix 9).

CWT loss was not significantly different in carcasses with both eyes (15.5%) versus those missing one or both eyes (12.5%) ($p > 0.05$; chi-square) (Appendix 10). A significant difference ($p < 0.05$) was noted between fresh (7.2%) and decomposed (27.5%) carcasses; however, CWT loss in carcasses with complete or partial (13.6%) and questionable (33.3%) AFCs was not significantly different (Appendix 10). When carcasses in the rotten and moderately rotten carcass categories were removed from the sample, the adjusted long-term CWT loss was 7.0%. No difference ($p>0.05$; chi-square) in CWT loss was noted between the study streams or between sexes (Appendix 9).

SAMPLING SELECTIVITY

Period

Temporal bias in the application sample was examined by comparing incidences in three recovery periods (Table 3). Temporal bias in the application sample was examined by comparing mark. Mark incidences ranged from 0.0% to 8.8%. The difference was significant ($p < 0.05$; chi-square) only in males. The highest mark incidences occurred in the early recovery period.

Recovery bias was examined by comparing the proportions recovered from three application periods (Table 4). The proportions ranged from 0.0% to 41.2%, with the difference being significant ($p < 0.05$) only for females.

Location

Spatial bias in the application sample was examined by comparing the mark incidences in five recovery sections (Table 5). Mark incidence ranged from 0.0% to 15.4%; the difference was significant ($p < 0.05$; chi-square) in females. Mark incidences were highest in the lower sections of Salmon River.

Recovery bias was examined by stratifying the application sample into five sections and comparing the proportions recovered (Table 6). The percentages ranged from 0.0% to 66.7%. The difference was significant ($p < 0.05$) only in males.

Fish Size

Size related bias in the application sample was examined by comparing POH length-frequency distributions of marked and unmarked spawning ground recoveries. No significant difference ($p > 0.05$; Kolmogorov-Smirnov two sample test) was noted in males or females. Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing NF length-frequency distributions of each. No significant difference ($p > 0.05$) was noted; however, when the data were stratified by 10 cm increments of nose-fork length, a trend to larger fish being recovered at a higher rate was observed (Table 7).

Fish Sex

No significant difference ($p > 0.05$; chi-square) was noted in the sex ratio of marked and unmarked spawning ground recoveries (Table 8). The application sample, therefore, was relatively unbiased with respect to sex.

No significant difference ($p > 0.05$) was noted in the sex ratio of the recovered and non-recovered components of the application sample (Table 8). Furthermore, no difference was noted in the proportion of males (18.2%) and females (29.8%) released with disk tags and recovered on the spawning grounds (Table 1).

Spawning Success

Spawning success, estimated from the internal examination of female spawning ground recoveries, was 96.1% (Appendix 11). Spawning success of marked (100%) and unmarked (95.8%) females was significantly different ($p > 0.05$; difference in proportions test).

ESTIMATION OF SPAWNER POPULATION

Total Escapement

Serious spatial and temporal biases were not identified in this study (Table 9; *see* Discussion), therefore escapement was calculated using the Petersen estimator. The 1994-1995 escapement of Salmon River coho adults was 1,941 (Table 10), with lower and upper 95% confidence limits of 1,144 and 2,737, respectively. The escapement of adult male and female coho was 1,160 and 781, respectively. Age 3_2 fish dominated the adult escapement (99.1%); only 0.9% were age 4_3.

The total escapement was allocated between the Salmon River and Coghlan Creek by applying proportions calculated from the Schaefer stratified estimate. The Salmon River accounted for 81% (1,572) of the total escapement, 84% (975) of the adult male escapement and 78% (609) of the female escapement.

Adipose Fin Clips and Coded Wire Tags

The AFC incidences in the Salmon River (31.5%) and Coghlan Creek (25.0%) were not significantly different ($p > 0.05$; chi-square). The AFC escapement, therefore, was derived from

the pooled AFC incidence of 29.0%. The AFC escapement was 563 adults, with lower and upper 95% confidence limits of 295 and 898, respectively (Table 10). The AFC escapement by stream was the product of the Petersen estimate for the entire system and the ratio of the stream specific Schaefer estimates. Of the estimated 563 coho adult AFC escapement, 457 returned to the Salmon River and 106 to Coghlan Creek (Table 11). Of the total, 153 returned with code 18-06-46, 316 with code 18-06-47, 54 with code 18-06-48, and 40 (7.0%) had lost the CWT. Survival from smolt release to adult escapement averaged 3.4%. There was a significant difference ($p < 0.5$; chi-square) in survival between the releases in Salmon River (3.7%) and Coghlan Creek (2.7%).

DISCUSSION

PROGRAM EFFECTIVENESS

The effectiveness of the 1991 brood juvenile program was evaluated by examining the number of smolts trapped and the AFC incidence in the subsequent adult escapement. The 1991 brood release of coded wire tagged coho smolts (15,611) was considerably lower than the previous seven year average of 22,489 (Table 12) while the AFC incidence in the subsequent escapement (29%) was the highest observed over the previous seven years and well above the average of 15% (Table 13). These data suggest that the efficiency of the 1993 trapping program was high and that smolt production was low. This is consistent with the observation that the traps were inoperative for only two or three days during the early period of emigration. The conclusion is supported by the smolt production index calculated for the 1984-1991 brood years (Table 12). The index is a Petersen estimate, scaled by a factor of 10^{-5}, using fin clipped smolts as the mark application sample, and the adult recovery as the census sample. Schubert *et al.* (1994b) indicated that the index was useful as a measure of tracking of gross changes in annual smolt production. The 1991 brood smolt index of 0.58 was the lowest recorded and well below the 1984-1990 brood average of 1.92.

The effectiveness of the 1991 brood adult program was evaluated by observing trends in the proportions of the population, which were handled during tag application and carcass recovery. In 1994-1995, after removal of fish with elecroshocker bruising, tags were applied to 4.7% of the population, well below the study period average of 8.5% (Table 13). The proportion of the escapement censused (24.7%) and of the marks recovered (24.2%) were well above the study period averages of 19% and 20%, respectively. These results indicate that the 1994-1995 marking program performance was below average, while the recapture effort was above average. This may result in reduced precision of the escapement estimate. To increase precision in future studies electroshocker stress must be reduced.

MARK-RECAPTURE STUDY

Population estimates derived from mark-recapture studies are susceptible to bias from a number of sources, including: tag loss; physiological stress which can induce the emigration of tagged fish from the population or alter recapture vulnerability; and non-representative tag application or recovery resulting from samples which are selective by fish size, sex or spatial

and temporal component. We evaluated the effect of capture and tagging on subsequent catchability and concluded that this assumption was not seriously violated in 1994-1995.

The application of excessive current by the electroshocker clearly influenced subsequent catchability or survival of bruised fish; however, this bias was addressed by removing the bruised fish from the analysis. Although this year's electroshocker and the current settings of the electroshocker were consistent with those used in 1993-1994, this year's observations contrasted the results of the 1993-1994 study (Schubert *et al.* 1994b). Well into this years study, a electromechanical fault within the electroshocker was identified and corrected. In future, lower catchability or survival of bruised, electroshocked fish should be avoided by preventative maintenance of the electroshocker.

It was not possible to definitively test the representativeness of the application and recovery samples because the true population parameters were not known. Instead, we examined the samples for four biases, temporal, spatial, fish size and fish sex, as indicators of weakness in the study design. Spatial and temporal biases were identified in the current study (Table 9); however, similar biases were not present in both the application and recovery samples of either sex. Junge (1963) noted that, when non-representative sampling occurs, accurate results may still be achieved if one sample is representative. Because we had no reason to believe that the samples were similarly biased, we concluded that the identified biases were unlikely to have introduced bias in the escapement estimate. We tested this assumption by comparing the Petersen estimate with the spatially stratified Schaefer's estimate. The Schaefer's estimate was 240 fish (12%) higher than the Petersen and well within the confidence limits of the Petersen estimate.

STOCK STATUS

The status of the Salmon River system coho salmon stock was inferred from trends in adult escapement, smolt production, exploitation rate and smolt to adult survival (Fig. 2). In an evaluation of stock status through the 1989 brood year, Schubert *et al.* (1994b) noted that an escapement collapse had occurred during a period of reduced smolt production and smolt to adult survival.

After six successive years of declining escapements, escapement increased in 1993-1994 (1990 brood year), in part due to a harvest reduction on the major age cohort (age 3_2) (Fig. 2 and Table 12). The 1991 brood year had the lowest escapement on record. Low smolt production and increased exploitation of the 1991 brood year are important factors in the low adult escapement returns in 1994-95

SUMMARY

1) The Salmon River (Langley) is one of several coho indicator stocks being monitored for responses to management actions by measuring annual escapement, marine survival, harvest distribution and exploitation rate. This report documents the 1991 brood year results.

2) Coded wire tags (CWTs) and adipose fin clips (AFCs) were applied to emigrant smolts at fence traps in Salmon River and Coghlan Creek, the principal tributary, from April 16 to May 31, 1993. Tagged smolts were transported and released below a pumphouse at the river mouth.

3) A total of 15,611 coho smolts were released with CWTs and AFCs. Size averaged 96.9 mm nose-fork length and 8.7 g wet weight.

4) Adult spawners were enumerated by a mark-recapture study from October 28, 1994 to January 20, 1995. Coho adults were captured using an electroshocker and marked with disk tags and opercular punches. Escapement was censused by the recovery of carcasses following spawning.

5) The 1994-1995 coho adult escapement was estimated from a tag application sample of 91, a recovery sample of 480, and a recovery of 22 tags or secondary marks. The escapement was estimated at 1,941 adults, of which 1,160 were male, 781 were female and 563 had AFCs. Long-term CWT loss was 7.0%.

6) The proportion of the smolt release, which returned to the spawning grounds, was 3.4%. The proportion was higher in Salmon River than in Coghlan Creek.

7) Most (99%) of the adult escapement was age 3_2. Adult POH length averaged 47.0 cm for females and 45.6 cm for males.

8) Spatial and temporal biases in the application and recovery samples were identified during this study; however, they were considered unlikely to have biased the escapement estimate.

9) The increased escapement observed in 1993-1994 was the result of increased smolt production and decreased exploitation rate.

10) The trend of escapement decrease was re-established in 1994-1995 and appears due to decreased smolt production and increased exploitation rate.

ACKNOWLEDGEMENTS

We would like to thank all those who participated in the field work on the Salmon River and contributed to the completion of this report. Thanks also to Joe Tadey for his input and help. Crews for the various years were as follows: 1993 tag application – Neil Schubert, Lanny Kalnin, Ed Humphrey and Bob Redden; 1994/1995 spawner enumeration – Ron Diewert, Lanny Kalnin, Tom Nevin, Ryan Galbraith, Andrew Walter, Andrew Lotto, Larry Sawchuk and Fiscus Chan.

REFERENCES

Armstrong, R.W. and A.W. Argue. 1977. Trapping and coded wire tagging of wild coho juveniles from the Cowichan River System, 1975. Fish. Mar. Serv. Tech. Rep. Ser. PAC/T 77-14: 58p.

Cochran, W.G. 1977. Sampling techniques, 3rd edition. John Wiley and Sons, New York. 428 p.

Environment Canada. 1980. Historic stream flow summary, British Columbia, to 1979. Inland Waters Directorate, Water Resources Branch, Ottawa. 861 p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1988 tag application and 1989-1990 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2079: 32 p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1992a. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1989 tag application and 1990-1991 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2114: 32 p.

Farwell, M.K., N.D. Schubert, and L.W. Kalnin. 1992b. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1990 tag application and 1991-1992 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2153: 42 p.

Farwell, M.K., N.D. Schubert, K.H. Wilson, and C.R. Harrison. 1987. Salmon escapements to streams entering statistical area 28 and 29, 1951 to 1985. Can. Data. Rep. Fish. Aquat. Sci. 601: 166 p.

Junge, C.O. 1963. A quantitative evaluation of the bias in population estimates based on selective samples. Int. Comm. North Atl. Fish. Spec. Pub. No. 4: 26-28.

Kalnin, L.W. and N.D. Schubert. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1987 tag application and 1988-1989 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2068: 37 p.

Kuhn, B.R., L. Lapi, and J.M. Hamer. 1988. An introduction to the Canadian database on marked Pacific salmonids. Can. Tech. Rep. Fish. Aquat. Sci. 1649: 56 p.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.

Russell, L.R. Unpublished manuscript. Pump mortality studies in the Salmon River (Fort Langley) and McLennan Creek (Matsqui), 1980: 8 p.

Schubert, N.D. 1982. Trapping and coded wire tagging of wild coho salmon smolts from the Salmon River (Langley), 1978 to 1980. Can. Manuscr. Rep. Fish. Aquat. Sci. 1972: 68 p.

Schubert, N.D. and J.O. Fleming. 1989. An evaluation of the escapement and survival of selected lower Fraser River area wild coho salmon stocks. Can. Manuscr. Rep. Fish. Aquat. Sci. 2006: 121 p.

Schubert, N.D., M.K. Farwell, and L.W. Kalnin. 1994a. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1991 tag application and 1992-1993 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2208: 39 p.

Schubert, N.D., M.K. Farwell, and L.W. Kalnin. 1994b. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1992 tag application and 1993-1994 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2241: 33 p.

Schubert, N.D. and L.W. Kalnin. 1990. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1986 tag application and 1987 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2053: 43 p.

Schubert, N.D. and M.R. Zallen. 1990. An evaluation of the harvest distribution, survival and exploitation rate of selected wild coho salmon stocks of the lower Fraser River area. Can. Manuscr. Rep. Fish. Aquat. Sci. 2052: 97 p.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry, the principles and practices of statistics in biological research, 2nd edition. W.H. Freeman and Co., New York. 859 p.

Staley, M.J. 1990. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of the Harrison River, 1984-1988. Can. Manuscr. Rep. Fish. Aquat. Sci. 2066: 42 p.

Table 1. Disk tag application, carcass examination and mark recovery, by sex, of Salmon River system coho adults, 1994-1995.

Sex	Disk tags applied a	Disk: Carcasses examined	Mark recovered: Tag and secondary mark b	Mark recovered: Secondary mark only	Mark recovered: Disk tag only	Mark recovered: Total	Percent recovered
Male	44	231	7	0	1 d	8	18.2%
Female	47	243	13	1	0	14	29.8%
Total	**91**	**480 c**	**20**	**1**	**1**	**22**	**24.2%**

a. Excludes 78 coho which were bruised at release.
b. Excludes 9 coho which were bruised at release.
c. Includes 6 coho of unknown sex.
d. Disc broken and number unreadable.

Table 2. Disk tag application and recovery of Salmon River system coho adults, by release condition, 1994-1995.

Category	Release condition	Disk tags applied	Disk tags recovered	Percent recovered
Swimming performance	Normal	157	27	17.2%
	Required ventilation	12	2	16.7%
Body bruising	None visible	90 a	19	21.1%
	Present	78	9	11.5%

a. Excludes one coho captured without shocking.

Table 3. Incidence of disk tags or secondary marks in coho adults recovered on the Salmon River system spawning grounds, by recovery period and sex, 1994-1995. a

Recovery period	Recovered with disk tag or secondary mark: Male	Female	Total	Total recovery: Male	Female	Total	Mark incidence: Male	Female	Total
25-Nov to 13-Dec	6	5	11	68	81	151 b	8.8%	6.2%	7.3%
14-Dec to 01-Jan	2	7	9	100	102	205 c	2.0%	6.9%	4.4%
02-Jan to 21-Jan	0	1	1	63	60	124 d	0.0%	1.7%	0.8%

a. Excludes 9 coho which were bruised at release
b. Includes two coho of unknown sex.
c. Includes three coho of unknown sex
d. Includes one coho of unknown sex.

Table 4. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application period and sex, 1994-1995.

Application period	Disk tags and secondary mark applied [a]			Carcasses recovered with disk tags [b]			Percent recovered		
	Male	Female	Total	Male [c]	Female	Total	Male	Female	Total
27-Oct to 12-Nov	19	12	31	1	0	1	5.3%	0.0%	3.2%
13-Nov to 30-Nov	11	17	28	4	7	11	36.4%	41.2%	39.3%
01-Dec to 23-Dec	14	18	32	2	6	8	14.3%	33.3%	25.0%

a. Excludes 78 coho which were bruised at release.
b. Excludes 9 coho which were bruised at release.
c. Excludes 1 coho with broken, unreadable disc tag.

Table 5. Proportion of the Salmon River system coho adult spawning ground recovery sample marked with disk tags or secondary marks, by recovery section and sex, 1994-1995.

Location	Recovery section [a]	Carcasses recovered with disk tags or secondary marks [b]			Coho adult carcasses examined [b]			Mark incidence		
		Male	Female	Total	Male [e]	Female	Total	Male	Female	Total
Salmon River	Lower	3	4	8 [c]	33	26	60 [c]	9.1%	15.4%	13.3%
	Middle	2	1	6 [e]	45	40	88 [e]	4.4%	2.5%	6.8%
	Upper	0	1	1	68	76	144	0.0%	1.3%	0.7%
Coghlan Creek	Lower	1	1	2	38	43	81	2.6%	2.3%	2.5%
	Upper	2	6	10 [d]	47	58	107 [d]	4.3%	10.3%	9.3%

a. Salmon River: lower - S1, S2; middle - S3; upper - S4, S5.
Coghlan Creek: lower - C1; upper - C2, C3, C4, C5.
b. Excludes 9 coho which were bruised at release.
c. Includes 1 coho of unknown sex.
d. Includes 2 coho of unknown sex.
e. Includes 3 coho of unknown.

Table 6. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application section and sex, 1994-1995.

Location	Application section [a]	Disk tags applied [b]			Carcasses recovered with disk tags [c]			Percent recovered		
		Male	Female	Total	Male [e]	Female	Total	Male	Female	Total
Salmon River	Lower	21	13	34	1	3	4	4.8%	23.1%	11.8%
	Middle	8	11	19	2	2	4	25.0%	18.2%	21.1%
	Upper	6	8	14	0	1	1	0.0%	12.5%	7.1%
Coghlan Creek	Lower	3	3	6	2	1	3	66.7%	33.3%	50.0%
	Upper	6	12	18	2	6	8	33.3%	50.0%	44.4%

a. Salmon River: lower - S1, S2; middle - S3; upper - S4, S5.
Coghlan Creek: lower - C1; upper - C2, C3, C4, C5.
b. Excludes 78 coho which were bruised at release.
c. Excludes 9 coho which were bruised at release
d. Excludes 9 coho which were bruised at release.
e. Excludes 1 coho with broken, unreadable disc tag.

Table 7. Proportion of the Salmon River system coho adult disk tag application sample recovered on the spawning grounds, by 10 cm increments of nose-fork length and sex, 1994-1995.

Nose-fork length (cm)	Disk tags applied a			Carcasses recovered with disk tags b			Percent recovered		
	Male	Female	Total	Male c	Female	Total	Male	Female	Total
30-39.9	2	0	2	0	0	0	0.0%	-	0.0%
40-49.9	8	4	12	0	1	1	0.0%	25.0%	8.3%
50-59.9	17	27	44	2	7	9	11.8%	25.9%	20.5%
60-69.9	17	16	33	5	5	10	29.4%	31.3%	30.3%

a. Excludes 78 coho which were bruised at release.
b. Excludes 9 coho which were bruised at release.
c. Excludes 1 coho with a broken, unreadable disc tag.

Table 8. Sex composition of Salmon River system coho adults in the disk tag application and spawning ground recovery samples, 1994-1995.

	Application sample sex ratio, by recovery status a				Recovery sample sex ratio, by mark status b			
Sex	Sample size	Recovered	Not recovered	Total	Sample size	Marked	Unmarked	Total
Male	44	34.8%	52.9%	48.4%	231	34.8%	49.0%	48.7%
Female	47	60.9%	48.5%	51.6%	243	60.9%	50.1%	51.3%

a. Excludes 78 coho which were bruised at release.
b. Excludes 9 coho which were bruised at release.

Table 9. Results of the statistical tests for bias in the 1994-1995 Salmon River system coho adult escapement estimation study. a

Bias type	Application sample	Recovery sample
Statistical	-	No bias
Period	Males biased to early period	Females biased to middle period
Location	Females biased to lower Salmon	Males biased to lower Coghlan
Fish size	No bias	No bias
Fish sex	No bias	No bias

a. A "no bias" test result indicates that bias was not detected; undetected biases may be present.

Table 10. Escapement estimates and 95% confidence limits, by sex and age, for Salmon River system coho adults, 1994-1995.

Group	Escapement by age			95% confidence limits on escapement estimate	
	3/2	4/3	Total	Lower	Upper
Male	1,146	14	1,160	455	1,865
Female	776	5	781	410	1,151
Total	1,922	19	1,941	1,144	2,737
AFC	-	-	563	295	898

Table 11. Smolt releases, adult escapement and survival to adult escapement, by location and CWT code, of 1991 brood Salmon River system coho salmon.

Location		CWT code			Adult escapement with an AFC but without a CWT
		18 06 46	18 06 47	18 06 48	
Salmon River	Number of smolts released a	-	9,005	912	-
	Spawning ground recoveries				
	Number	11	44	8	-
	Percent by code	17.5%	69.8%	12.7%	-
	Escapement b	74	297	54	32
Coghlan Creek	Number of smolts released a	5,694	-	-	-
	Spawning ground recoveries				
	Number	25	6	0	-
	Percent by code	80.6%	19.4%	0.0%	-
	Escapement b	79	19	0	8
Total	Escapement	153	316	54	40
	Survival to escapement	2.7%	3.5%	5.9%	-

a. Adjusted for long-term CWT loss.
b. Product of the stream-specific escapement, pooled AFC incidence, pooled CWT retention, and proportion by code.

Table 12. Trends in smolt production, smolt-to-adult survival, exploitation rate and escapement of coded wire tagged 1984-1991 brood Salmon River system coho salmon.

Dominant brood year	Smolts released with CWT's [a]	Smolt production index	Fishery CWT harvest [b]	Adult CWT escapement [c]	Total survival	Exploitation rate [e]	Adult escapement in brood year + 3
1984	7,891	2.94	852	373	15.5	69.6	11,947
1985	20,022	1.60	3,292	1,102	21.9	74.9	9,152
1986	24,634	2.39	2,419	903	13.5	72.8	8,427
1987	26,911	1.69	2,676	801	12.9	77.0	4,942 [d]
1988	20,390	2.13	1,202	371	7.7	76.4	4,321
1989	29,435	1.15	2,105	730	9.6	74.3	2,604
1990	28,141	1.52	1,290	1,079	8.4	54.5	5,913
1991	15,611	0.58	999	523	9.7	65.6	1,941

[a] Corrected for long term CWT loss.

[b] Harvest in brood year + 3 only. In some cases the CWT harvest may be a little higher than earlier estimates as PMFC (Pacific Marine Fisheries Commission) numbers were not available in some years, but have been added here. The influence is in all cases very small.

[c] Data for brood year 1984-1988,inclusive recalculated from Farwell et al.(1992) using AFC

incidence stratified by stream;1989-1992 data follow same procedure.

[d] Recalculated from Farwell et al. (1991) to correct an error in the mark -recapture data.

[e] Catch / catch and escapement

Table 13. Program effectiveness as indicated by the capture, marking, and recapture of adult coho in the Salmon River system, 1987-1988 through 1994-1995.

		Application sample		Recovery sample			Disk tags or secondary marks recovered	
Year	Adult escapement	Number	Percent of escapement	Number	Percent of escapement	AFC incidence	Number	Percent recovered
1987-1988	11,947	1,322	11.1%	3,302	27.6%	3.4%	352	26.6%
1988-1989	9,152	717	7.8%	1,377	15.0%	14.4%	107	14.9%
1989-1990	8,427	495	5.9%	1,327	15.7%	10.9%	80	16.2%
1990-1991	4,942 a	430	8.7%	864	17.5%	19.4%	75	17.4%
1991-1992	4,321	405	9.4%	696	16.1%	10.3%	66	16.3%
1992-1993	2,604	152	5.8%	460	17.7%	26.8%	25	16.4%
1993-1994	5,913	490	8.3%	1,045	17.7%	20.0%	84	17.1%
1994-1995	1,941	91	4.7%	480	24.7%	29.0%	22	24.2%

a. Recalculated from Farwell et al. (1991) to correct an error in the mark-recapture data.

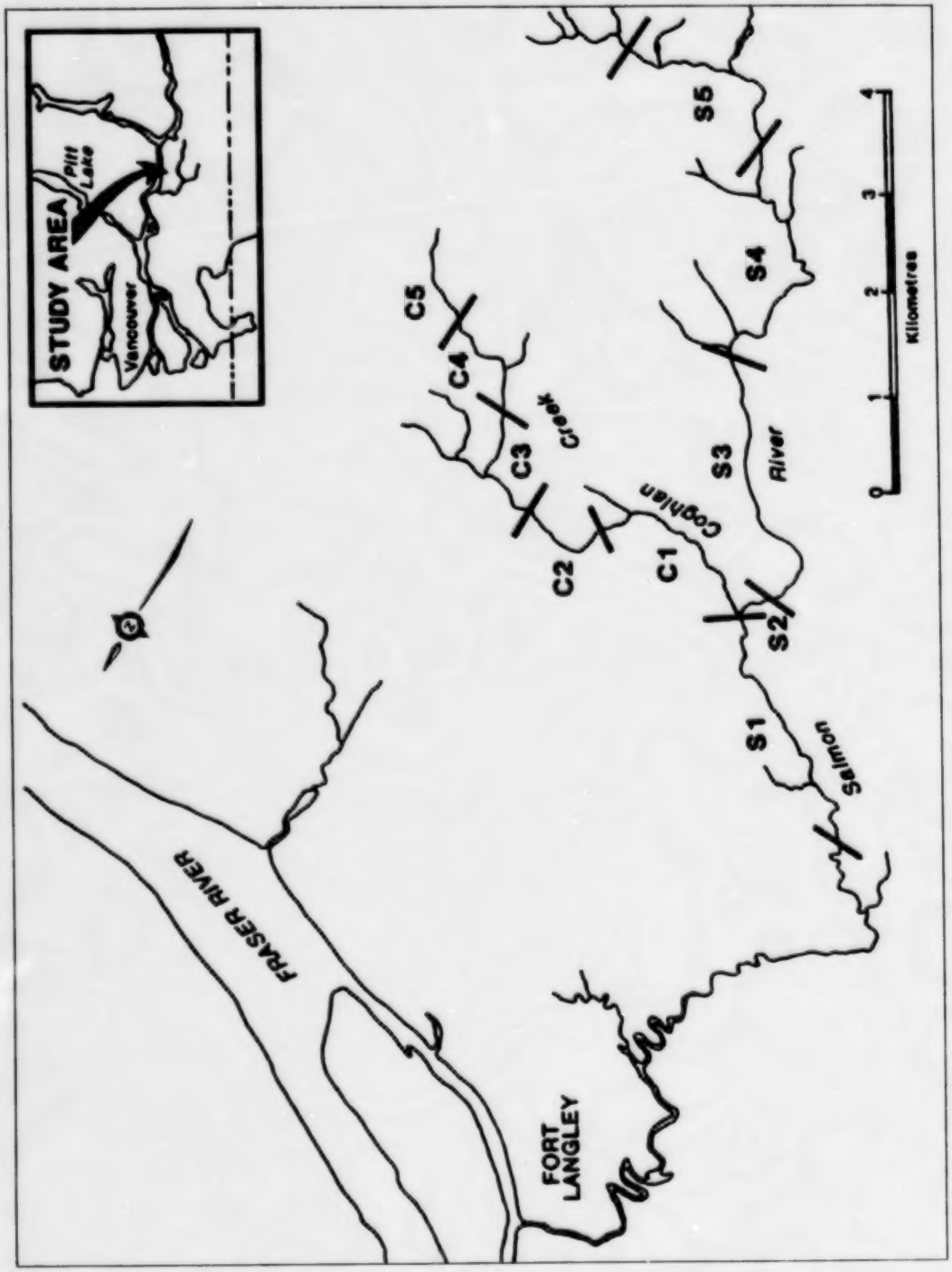

Fig 1. The Salmon River and Coghlan Creek showing reach locations.

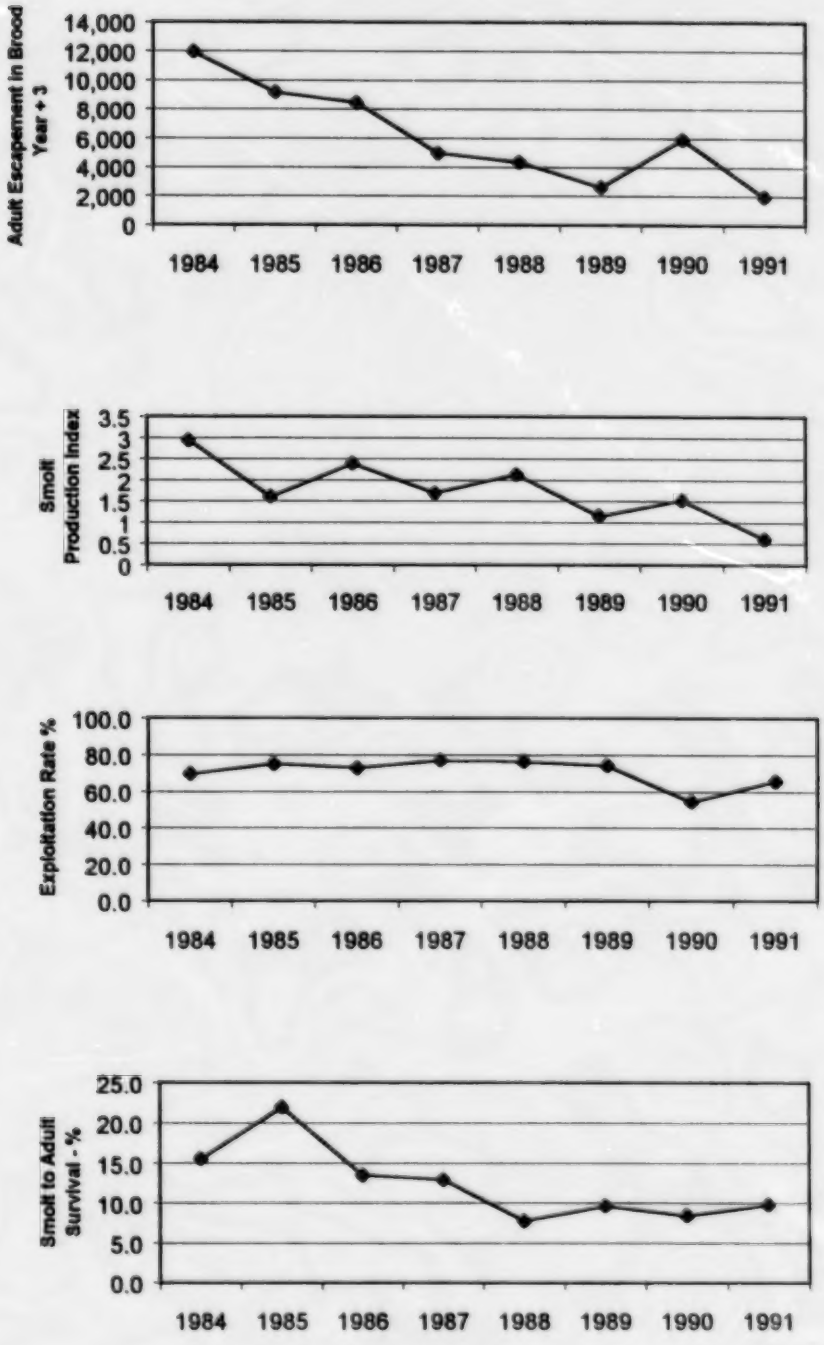

Fig. 2. Trends in adult escapement, smolt production, exploitation rate and smolt-to-adult survival, by brood year, in 1984-1991 brood Salmon River system coho salmon.

Appendix 1a. Daily enumeration of downstream migrants, by species, at the Salmon River fence trap, 1993.

Date	Water temp (°C) a	Water level (m) a	Coho	Cutthroat trout		Rainbow trout		Lamprey	Sculpin	Stickle back	Crayfish	Sucker
			Smolt	Smolt	Parr	Smolt	Parr					
21-Apr	11.0	0.18	0	0	0	0	0	1	0	1	0	0
22-Apr	11.0	0.18	3	0	0	0	0	1	0	0	0	0
23-Apr	11.0	0.18	470	2	0	8	5	0	7	0	1	1
24-Apr	11.0	0.19	256	1	0	29	8	8	0	1	0	0
25-Apr	10.5	0.23	161	1	0	2	1	8	0	0	1	0
26-Apr	9.5	0.30	46	0	0	0	2	0	0	0	0	0
27-Apr b	9.5	0.41	-	-	-	-	-	-	-	-	-	-
28-Apr b	-	0.40	-	-	-	-	-	-	-	-	-	-
29-Apr	10.0	0.36	20	1	0	1	0	1	0	1	1	0
30-Apr	10.5	0.28	294	4	0	8	4	3	0	0	0	0
01-May	10.3	0.23	79	0	0	2	0	2	0	0	0	0
02-May	10.0	0.35	2	0	2	1	0	0	0	0	0	0
03-May b	-	0.33	-	-	-	-	-	-	-	-	-	-
04-May	10.5	0.23	273	0	1	2	1	1	0	0	0	0
05-May	10.0	0.20	132	4	0	4	0	0	0	0	0	0
06-May	10.0	0.29	687	5	0	14	4	0	0	1	0	0
07-May	10.5	0.24	1,172	5	3	21	12	1	0	0	0	1
08-May	9.5	0.23	189	3	0	6	0	0	0	0	0	0
09-May	12.0	0.22	572	1	0	7	1	0	0	0	0	0
10-May	11.3	0.33	628	0	0	1	1	0	0	0	0	0
11-May	13.3	0.24	713	4	6	7	3	3	0	1	1	0
12-May	13.5	0.20	877	5	0	1	4	0	0	1	4	2
13-May	13.0	0.20	1,059	14	1	4	6	0	0	0	2	1
14-May	12.3	0.19	1,026	1	1	4	1	2	0	0	0	1
15-May	12.0	0.18	278	1	3	3	9	0	0	0	2	0
16-May	12.5	0.19	286	13	2	6	2	0	0	0	2	1
17-May	-	0.18	301	4	0	1	3	0	0	0	5	4
18-May	13.0	0.17	229	3	2	0	2	0	0	0	3	1
19-May	14.0	0.16	229	8	3	5	6	0	0	0	5	5
20-May	15.0	0.20	568	7	3	2	3	0	0	1	3	0
21-May	14.0	0.19	680	16	0	1	8	1	0	0	7	13
22-May	14.0	0.19	179	6	1	0	1	0	0	1	4	0
23-May	14.5	0.18	14	0	0	0	0	0	0	0	3	1
24-May	15.0	0.17	8	0	0	0	0	2	1	0	4	2
25-May	14.5	0.17	74	2	1	0	0	2	0	2	3	1
26-May	14.5	0.16	62	3	0	0	0	0	0	0	0	0
27-May	14.5	0.15	57	4	0	0	0	2	0	0	1	7
28-May	15.0	0.20	18	0	0	0	0	0	0	0	6	0
29-May	14.3	0.19	67	0	0	0	0	0	0	0	3	10
30-May	14.5	0.19	22	0	0	0	0	0	0	0	6	1
31-May	15.0	0.18	1	0	0	0	0	0	0	0	5	1
Total	-	-	11,732	118	29	140	87	38	8	10	72	53

a. Recorded at approximately 0900 hrs.
b. Trap not fishing due to high water.

Appendix 1b. Daily enumeration of downstream migrants, by species, at the Coghlan Creek fence trap, 1993.

Date	Water temp (°C) a	Water level (m) a	Coho	Cutthroat trout		Rainbow trout		Lamprey	Sculpin	Stickle back	Crayfish	Sucker
			Smolt	smolt	parr	smolt	parr					
16-Apr	9.0	0.19	12	12	2	6	12	0	0	0	0	0
17-Apr	9.8	0.19	21	8	0	7	1	1	1	0	0	0
19-Apr	9.0	0.19	81	29	3	29	16	1	0	0	0	0
20-Apr	9.0	0.21	58	12	0	12	15	0	0	0	2	0
21-Apr	10.1	0.19	68	17	10	11	13	0	0	0	1	1
22-Apr	10.0	0.18	144	12	1	10	11	0	0	0	2	0
23-Apr	10.0	0.18	261	17	1	17	18	2	0	0	0	0
24-Apr	10.3	0.19	69	6	1	3	9	0	0	0	0	0
25-Apr	10.0	0.32	331	70	15	31	21	0	0	0	1	0
26-Apr b	9.0	0.29	-	-	-	-	-	-	-	-	-	-
27-Apr	9.0	0.37	19	0	5	2	0	0	0	0	0	0
28-Apr b	-	-	-	-	-	-	-	-	-	-	-	-
29-Apr	9.5	0.37	25	5	0	1	0	0	0	0	1	0
30-Apr	10.0	0.26	335	35	2	9	7	0	0	1	0	2
01-May	9.8	0.24	167	43	5	2	3	0	0	0	1	1
02-May	10.0	0.30	31	0	0	0	0	0	0	0	0	0
03-May	9.5	0.00	105	3	0	0	0	0	0	0	0	0
04-May	10.0	0.22	148	21	1	1	1	0	0	0	0	0
05-May	9.5	0.19	332	35	1	6	3	0	0	0	1	0
06-May	9.5	0.28	398	109	7	11	2	0	0	0	4	0
07-May	9.5	0.24	729	76	1	11	11	0	1	0	1	0
08-May	10.0	0.24	164	50	2	2	5	0	0	2	6	0
09-May	10.0	0.21	300	36	1	6	3	0	0	0	1	0
10-May	11.0	0.33	301	50	2	6	6	1	0	0	5	0
11-May	13.0	0.24	635	125	10	11	14	0	0	1	0	0
12-May	12.0	0.20	327	52	3	3	11	2	0	2	0	0
13-May	12.0	0.19	246	69	7	6	15	2	0	1	4	0
14-May	11.5	0.00	363	13	5	1	11	1	0	0	1	0
15-May	11.0	0.18	44	4	1	0	1	1	0	0	4	1
16-May	11.0	0.18	44	46	6	4	4	0	0	1	4	0
17-May	11.0	0.19	74	4	1	0	0	0	0	0	10	0
18-May	12.0	0.16	36	16	0	0	0	0	0	0	7	0
19-May	12.5	0.16	103	25	1	1	2	0	0	0	0	0
20-May	14.0	0.21	113	42	5	0	1	1	0	0	4	0
21-May	12.5	0.19	65	84	6	1	9	0	0	0	3	0
22-May	12.2	0.19	6	1	1	0	0	0	0	1	3	0
23-May	12.5	0.16	21	6	3	1	0	1	0	0	3	0
24-May	14.5	0.16	28	26	0	0	0	0	0	0	4	0
25-May	13.0	0.16	26	21	1	0	3	0	0	0	1	1
26-May	12.5	0.15	6	0	0	0	0	0	0	0	1	0
27-May	13.0	0.15	20	6	4	0	3	0	0	0	2	0
28-May	13.0	0.20	24	22	5	0	2	0	0	0	2	0
29-May	13.0	0.17	17	19	6	0	1	0	0	0	0	1
30-May	12.0	0.16	7	7	0	1	0	0	0	0	4	1
31-May	13.0	0.15	6	7	1	0	1	0	0	1	4	0
Total	-	-	6,310	1,241	126	212	235	13	2	10	87	8

a. Recorded at approximately 0845 hrs.
b. Trap out due to high water.

Appendix 2a. Application of coded wire tags, by code and date, to Salmon River coho salmon smolts, 1993.

CWT Code	Tagging date	Maximum holding time (days)	Pre-tagging mortality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
18/06/47	23-Apr	0	0	468	462	4.1	0	1	413
	26-Apr	2	1	452	233	0.0	0	4	413
	30-Apr	1	1	307	224	11.2	1	5	245
	04-May	2	2	319	173	1.2	0	0	291
	05-May	0	0	131	130	8.5	0	1	110
	06-May	0	0	671	223	17.5	4	12	496
	07-May	0	0	999	274	7.3	0	44	814
	10-May	2	0	1,365	300	2.0	27	5	1,204
	11-May	0	0	627	305	19.0	27	16	428
	12-May	0	0	868	200	1.0	0	0	791
	13-May	0	0	1,057	311	1.0	0	0	965
	17-May	3	31	1,859	330	0.3	0	6	1,704
	18-May	0	0	229	258	0.4	0	3	208
	19-May	0	0	229	229	0.0	0	0	211
	20-May	0	0	565	157	0.0	0	4	517
	21-May	0	0	214	211	0.9	0	0	195
Total (mean)		(0.6)	35	10,360	4,020	(4.7)	59	101	9,005
18/06/48	21-May	0	0	457	211	0.9	0	0	417
	25-May	2	0	343	136	1.5	0	10	302
	27-May	2	0	114	114	0.0	0	0	105
	31-May	3	4	95	95	0.0	0	0	88
	Total (mean)	(1.8)	4	1,009	556	(0.7)	0	10	912
Total (mean)		(1.1)	39	11,369	4,576	(4.2)	59	111	9,917

a. Sample size held to assess tag loss.
b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.
c. Adjusted for long-term CWT loss (see text).

Appendix 2b. Application of coded wire tags, by code and date, to Coghlan Creek coho salmon smolts, 1993.

CWT code	Tagging date	Maximum holding time (days)	Pre-tagging mortality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
18/06/46	21-Apr	5	0	188	188	4.3	0	0	171
	22-Apr	0	0	144	144	0.0	0	0	137
	23-Apr	0	0	261	259	0.0	0	1	247
	26-Apr	2	6	397	261	0.8	0	0	374
	30-Apr	3	0	344	296	3.0	0	6	311
	04-May	4	0	448	180	0.6	0	0	423
	05-May	0	0	331	138	2.2	0	0	308
	06-May	0	0	396	162	6.8	0	0	351
	07-May	0	0	726	168	2.4	0	4	669
	08-May	0	0	164	164	9.1	0	1	141
	10-May	2	2	588	200	1.5	0	6	544
	11-May	0	0	603	121	1.7	0	5	558
	12-May	0	0	326	141	0.0	0	0	310
	13-May	0	0	246	56	1.8	0	0	230
	17-May	3	0	514	310	0.0	0	2	487
	18-May	0	0	34	0	0.4	1	0	31
	19-May	0	0	103	102	0.0	0	2	96
	20-May	0	0	109	109	0.0	0	0	104
	21-May	0	0	65	65	0.0	0	0	62
	25-May	4	0	74	74	1.5	0	0	68
	27-May	2	0	27	27	0.0	0	0	26
	31-May	4	0	51	51	0.0	0	0	48
Total (mean)		(1.3)	8	6,139	3,216	(1.9)	1	27	5,694

a. Sample size held to assess tag loss.
b. Based on mortality rate observed in QCD sub-sample expanded to entire tag lot.
c. Adjusted for long-term CWT loss (see text).

Appendix 3. Anomalies encountered while coded wire tagging wild Salmon River system coho salmon smolts, 1993.

Location	Number inspected	Fog eye	Neascus	Scoliosis	Fin rot	General damage	Naturally missing adipose fin
Salmon River	11,369	1,108 9.7%	184 1.62%	5 0.04%	95 0.84%	6 0.05%	0 0.00%
Coghlan Creek	6,138	692 11.3%	0 0.00%	13 0.21%	56 0.91%	0 0.00%	0 0.00%
Total	17,507	1,800 10.3%	184 1.05%	18 0.10%	151 0.86%	6 0.03%	0 0.00%

Appendix 4. Mean length and weight, by location and date, of coho salmon smolts in the Salmon River system, 1993.

Location	Sample date	Sample size	Nose-Fork length (mm)		Mean wet weight (g)
			Mean	Standard deviation	
Salmon River	23-Apr	50	84.7	9.3	6.6
	30-Apr	50	92.3	7.9	-
	04-May	50	98.1	14.8	9.9
	07-May	50	103.9	13.9	11.4
	11-May	50	98.6	12.7	9.9
	14-May	50	98.4	10.1	10.0
	18-May	50	94.9	10.0	9.0
	21-May	49	93.1	10.2	8.8
	25-May	50	94.2	8.6	-
	28-May	18	95.8	8.1	9.0
	Total	467	97.3 a	-	8.9 a
Coghlan Creek	23-Apr	50	91.8	9.1	8.7
	30-Apr	50	100.3	11.0	-
	03-May	50	97.5	10.1	9.8
	07-May	50	97.8	8.9	9.9
	11-May	50	96.6	8.9	9.4
	14-May	50	94.9	5.3	9.3
	18-May	30	93.0	4.7	8.2
	21-May	50	94.6	7.1	8.8
	25-May	22	93.3	3.8	8.5
	28-May	24	92.1	5.2	8.4
	Total	426	96.4 a	-	8.2 a
Total	-	893	96.9 a	-	8.7 a

a. Weighted by proportion of smolt migration in time periods.

Appendix 5a. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in the Salmon River, 1994-1995.

Date	Reach a	Electro shocker volts	Released unbruised			Released with electroshocker bruising			Total			Adipose absent b	
			Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
28-Oct	S1	200	7	4	11	1	2	3	8	6	14	3	2
	S2	200	0	0	0	0	1	1	0	1	1	0	1
		300	1	0	1	2	0	2	3	0	3	0	0
31-Oct	S1	200	0	0	0	3	0	3	3	0	3	0	0
	S3	200	0	0	0	0	2	2	0	2	2	0	0
2-Nov	S1	300	4	2	6	4	2	6	8	4	12	0	2
	S2	200	1	0	1	0	0	0	1	0	1	0	0
	S3	200	0	1	1	1	0	1	1	1	2	0	0
4-Nov	S3	200	0	0	0	2	1	3	2	1	3	1	0
		300	1	1	2	1	0	1	2	1	3	0	0
7-Nov	S4	200	2	2	4	6	1	7	8	3	11	0	1
14-Nov	S1	300	1	0	1	0	2	2	1	2	3	0	1
	S2	300	1	0	1	3	3	6	4	3	7	0	1
18-Nov	S3	400	1	5	6	4	5	9	5	10	15	1	0
21-Nov	S1	400	0	1	1	5	1	6	5	2	7	0	1
	S2	400	1	0	1	0	1	1	1	1	2	1	0
23-Nov	S4	300	1	0	1	0	0	0	1	0	1	1	0
	S5	300	0	0	0	1	1	2	1	1	2	0	0
		400	1	2	3	1	0	1	2	2	4	0	0
2-Dec	S3	200	3	3	6	1	1	2	4	4	8	0	0
5-Dec	S1	200	3	3	6	2	0	2	5	3	8	0	0
	S2	200	2	1	3	1	1	2	3	2	5	1	0
7-Dec	S3	200	3	1	4	0	1	1	3	2	5	1	0
	S4	200	0	2	2	0	0	0	0	2	2	0	0
12-Dec	S5	200	2	2	4	1	1	2	3	3	6	3	1
19-Dec	S2	300	0	2	2	0	1	1	0	3	3	0	0
Total	S1	-	15	10	25	15	7	22	30	17	47	3	6
	S2	-	6	3	9	6	7	13	12	10	22	2	2
	S3	-	8	11	19	9	10	19	17	21	38	3	0
	S4	-	3	4	7	6	1	7	9	5	14	1	1
	S5	-	3	4	7	3	2	5	6	6	12	3	1
Total	-	-	35	32	67	39	27	66	74	59	133	12	10

a. Salmon River reaches: S1 - below Coghlan Creek. S4 - 56 Ave. to 248 St.

S2 - Coghlan Creek to 64 Ave. S5 - 248 St. to 256 St.

S3 - 64 Ave. to 56 Ave.

b. Included in 'Total' column.

Appendix 5b. Daily application of disk tags and secondary marks, by reach, release condition, adipose fin status and sex, to coho adults in Coghlan Creek, 1994-1995.

Date	Reach a	Electro shocker volts	Released unbruised			Released with electroshocker bruising			Total			Adipose absent b	
			Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
31-Oct	C1	200	1	0	1	0	0	0	1	0	1	1	0
4-Nov	C1	300	1	1	2	2	0	2	3	1	4	1	0
7-Nov	C2	200	0	1	1	0	0	0	0	1	1	0	0
9-Nov	C2	200	1	0	1	0	0	0	1	0	1	0	0
16-Nov	C1	400	1	1	2	5	2	7	6	3	9	1	1
21-Nov	C1	300	0	0	0	1	0	1	1	0	1	0	0
23-Nov	C2	300	3 c	0	3	0	0	0	3	0	3	1	0
		400	0	1	1	0	0	0	0	1	1	0	0
	C3	300	0	1	1	0	0	0	0	1	1	0	0
	C5	300	1	6	7	0	0	0	1	6	7	0	3
19-Dec	C1	300	0	1	1	0	0	0	0	1	1	0	0
21-Dec	C3	200	0	1	1	0	0	0	0	1	1	0	0
	C5	200	1	2	3	1	1	2	2	3	5	0	0
Total	C1	-	3	3	6	8	2	10	11	5	16	3	1
	C2	-	4	2	6	0	0	0	4	2	6	1	0
	C3	-	0	2	2	0	0	0	0	2	2	0	0
	C4	-	0	0	0	0	0	0	0	0	0	0	0
	C5	-	2	8	10	1	1	2	3	9	12	0	3
	Total	-	9	15	24	9	3	12	18	18	36	4	4

a. Coghlan Creek reaches:

C1 - Salmon River to Hwy. 1.

C2 - Hwy. 1 to 248 St.

C3 - 248 St. to 64 Ave.

C4 - 64 Ave. to 256 St.

C5 - Above 256 St.

b. Included in 'Total' column.

c. Includes 1 coho captured without electroshocking.

Appendix 6. Disk tag and secondary mark recoveries, by application and recovery date and location, size, sex, adipose fin status and disk tag number, of coho salmon adults released in the Salmon River system, 1994-1995.

Application sample								Recovery sample					
Date	Reach a	Electro shoker Volts	NF length (cm)	Sex	Adipose fin	Disk tag number		Date	Reach a	POH length (cm)	Sex	Age	Days out
31-Oct	C1	200	53.0	M	A	6018		25-Nov	S1	42.2	M	3/2	25
4-Nov	S3	300	59.0	M	P	6043	c	29-Dec	C1	40.6	M	3/2	55
14-Nov	S1	300	61.5	F	A	6064	c	25-Nov	S1	48.7	F	3/2	11
16-Nov	C1	400	61.5	M	P	6078		2-Dec	C1	49.8	M	3/2	16
16-Nov	C1	400	50.5	M	P	6080	c	12-Dec	C1	41.9	M	3/2	26
16-Nov	C1	400	51.0	M	P	6081	c	23-Dec	C1	39.0	M	3/2	37
18-Nov	S3	400	69.0	M	P	6082	c	23-Dec	S1	55.0	M	R	35
18-Nov	S3	400	62.0	F	P	6083		2-Dec	S1	51.5	F	R	14
18-Nov	S3	400	57.0	M	P	6095		7-Dec	S3	43.6	M	3/2	19
21-Nov	S1	400	57.5	F	A	6100	b,c	25-Nov	S1	48.1	F	3/2	4
21-Nov	S1	400	60.0	M	P	6103	c	23-Dec	C1	45.5	M	3/2	32
21-Nov	S1	400	49.5	F	P	6104		14-Dec	S1	40.9	F	3/2	23
21-Nov	C1	300	63.0	M	P	6107	c	13-Jan	S4	50.9	M	3/2	53
23-Nov	C2	400	63.5	F	P	6115		12-Dec	C2	52.1	F	3/2	19
23-Nov	C2	d	63.0	M	A	6116	d	2-Dec	C2	49.7	M	3/2	9
23-Nov	C2	300	64.0	M	P	6118		23-Dec	C2	49.7	M	R	30
23-Nov	C5	300	52.0	F	P	6122		30-Nov	C5	42.3	F	R	7
23-Nov	C5	300	60.0	F	P	6123		30-Nov	C4	49.4	F	3/2	7
23-Nov	C5	300	54.0	F	P	6124		14-Dec	C4	46.3	F	3/2	21
23-Nov	C5	300	54.0	F	A	6125		30-Nov	C5	45.5	F	3/2	7
2-Dec	S3	200	66.0	M	P	6132		14-Dec	S3	49.8	M	3/2	12
2-Dec	S3	200	53.0	F	P	6133		14-Dec	S3	43.4	F	3/2	12
5-Dec	S2	200	60.5	F	P	6143		14-Dec	S1	48.4	F	R	9
5-Dec	S2	200	65.0	M	A	6144	b	9-Dec	S2	53.0	M	R	4
12-Dec	S5	200	52.5	F	P	6155		14-Dec	S5	43.7	F	R	2
19-Dec	S2	200	57.0	F	P	6161		23-Dec	S1	47.1	F	3/2	4
19-Dec	C1	300	52.0	F	P	6164		23-Dec	C1	43.6	F	3/2	4
21-Dec	C5	200	60.0	M	P	6167	c	5-Jan	C3	46.3	M	3/2	15
21-Dec	C5	200	64.0	F	P	6168		11-Jan	C5	49.3	F	R	21
Application data unknown, tag broken, number unreadable								25-Nov	S1	50.6	M	R	n/a
Application data unknown, tag lost								15-Dec	C1	50.4	F	R	n/a

			Mean days out:	18.4
Females initially identified as males:	0	0.0%	Max. days out:	55.0
Males initially identified as females:	0	0.0%	Min. days out:	2.0

POH length and NF length regressions:

Males: POH length = 0.79 NF length - 0.86
NF length = 1. 03 POH length + 11.62

Females: POH length = 0.67 NF length + 8.53
NF length = 1.34 POH length - 5.69

a. See Appendix 5 for reach descriptions.

b. Required ventilation at release.

c. Bruised at release.

d. Captured without electroshocking.

Appendix 7a. Daily coho carcass recoveries, by reach, mark status and sex, in the Salmon River, 1994-1995.

		Unmarked			Disk tag and secondary mark		Secondary mark only		Total			Adipose absent a		
Date	Reach	Male	Female	Jack	Male	Female	Male	Female	Male	Female	Jack	Male	Female	Jack
25-Nov	S1 b	7	5	0	2 d	2 e	0	0	9	7	0	5	3	0
	S3 b	10	3	0	0	0	0	0	10	3	0	5	1	0
28-Nov	S2	1	1	0	0	0	0	0	1	1	0	0	1	0
	S4	4	4	0	0	0	0	0	4	4	0	2	2	0
2-Dec	S1	0	1	0	0	1	0	0	0	2	0	0	0	0
7-Dec	S3	11	15	0	1	0	0	0	12	15	0	4	4	0
9-Dec	S1	0	1	0	0	0	0	0	0	1	0	0	1	0
	S2	1	0	0	1	0	0	0	2	0	0	1	0	0
	S4	8	8	0	0	0	0	0	8	8	0	2	2	0
	S5	0	4	0	0	0	0	0	0	4	0	0	1	0
14-Dec	S1	2	1	0	0	2	0	0	2	3	0	0	0	0
	S2	3	1	0	0	0	0	0	3	1	0	0	1	0
	S3 c	9	9	0	1	1	0	0	10	10	0	1	3	0
	S4	9	10	0	0	0	0	0	9	10	0	4	2	0
	S5	5	4	0	0	1	0	0	5	5	0	1	2	0
15-Dec	S4	7	6	0	0	0	0	0	7	6	0	2	0	0
23-Dec	S1	6	6	0	1 e	1	0	0	7	7	0	2	5	0
30-Dec	S3	7	3	0	0	0	0	0	7	3	0	1	1	0
	S4	14	17	0	0	0	0	0	14	17	0	2	5	0
	S5	2	4	0	0	0	0	0	2	4	0	0	0	0
3-Jan	S1	2	1	0	0	0	0	0	2	1	0	1	1	0
	S2	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Jan	S5	3	2	0	0	0	0	0	3	2	0	0	1	0
6-Jan	S3	6	8	0	0	0	0	0	6	8	0	3	4	0
	S4	5	3	0	0	0	0	0	5	3	0	1	0	0
9-Jan	S1	3	1	0	0	0	0	0	3	1	0	1	1	0
	S2	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jan	S5	3	1	1	0	0	0	0	3	1	1	2	1	0
13-Jan	S3	0	2	0	0	0	0	0	0	2	0	0	1	0
	S4	7	7	0	1 e	0	0	0	8	7	0	2	4	0
19-Jan	S5	1	5	0	0	0	0	0	1	5	0	1	2	0
20-Jan	S1	5	2	0	0	0	0	0	5	2	0	1	0	0
	S2	0	1	0	0	0	0	0	0	1	0	0	0	0
Total	S1	25	18	0	3	6	0	0	28	24	0	10	11	0
	S2	5	3	0	1	0	0	0	6	3	0	1	2	0
	S3	43	40	0	2	1	0	0	45	41	0	14	14	0
	S4	54	55	0	1	0	0	0	55	55	0	15	15	0
	S5	14	20	1	0	1	0	0	14	21	1	4	7	0
	Total	141	136	1	7	8	0	0	148	144	1	44	49	0

a. Included in 'Total' column.
b. Excludes 1 unmarked coho of unknown sex.
c. Excludes 2 unmarked coho of unknown sex.
d. Includes 1 coho with broken, unreadable disc tag and no secondary mark.
e. Bruised at time of release.

Appendix 7b. Daily coho carcass recoveries, by reach, mark status and sex, in the Coghlan Creek, 1994-1995.

		Unmarked			Disk tag and secondary mark		Secondary mark only		Total			Adipose absent a		
Date	Reach	Male	Female	Jack	Male	Female	Male	Female	Male	Female	Jack	Male	Female	Jack
25-Nov	C1	8	3	0	0	0	0	0	8	3	0	2	0	0
30-Nov	C4	0	1	0	0	1	0	0	0	2	0	0	0	0
	C5	0	0	0	0	2	0	0	0	2	0	0	1	0
2-Dec	C1	4	3	0	1	0	0	0	5	3	0	1	1	0
	C2	2	6	0	1	0	0	0	3	6	0	1	1	0
7-Dec	C3	2	2	0	0	0	0	0	2	2	0	1	1	0
	C4	1	6	0	0	0	0	0	1	6	0	1	3	0
	C5	0	1	0	0	0	0	0	0	1	0	0	1	0
12-Dec	C1	2	9	0	1 d	0	0	0	3	9	0	0	1	0
	C2	1	3	0	0	1	0	0	1	4	0	1	0	0
14-Dec	C3	4 b	2	0	0	0	0	0	4	2	0	1	1	0
	C4	1	3	0	0	1	0	0	1	4	0	1	0	0
15-Dec	C5	0	0	0	0	0	0	1	0	1	0	0	1	0
23-Dec	C1	6	10	0	2 d	1	0	0	8	11	0	2	0	0
	C2	4	7	0	1	0	0	0	5	7	0	2	3	0
29-Dec	C1	7	5	1	1 d	0	0	0	8	5	1	2	2	0
	C2	6	1	0	0	0	0	0	6	1	0	2	0	0
	C3	5	2	0	0	0	0	0	5	2	0	1	1	0
	C4	1	2	0	0	0	0	0	1	2	0	0	0	0
	C5	0	1	0	0	0	0	0	0	1	0	0	0	0
3-Jan	C1	3	2	0	0	0	0	0	3	2	0	0	0	0
	C2	0 c	2	0	0	0	0	0	0	2	0	0	0	0
5-Jan	C3	1	1	0	1 d	0	0	0	2	1	0	0	0	0
	C4	4	1	0	0	0	0	0	4	1	0	2	0	0
	C5	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Jan	C1	3	6	0	0	0	0	0	3	6	0	1	1	0
	C2	3	1	1	0	0	0	0	3	1	1	0	1	0
11-Jan	C3	1	1	0	0	0	0	0	1	1	0	0	0	0
	C4	3	5	0	0	0	0	0	3	5	0	0	1	0
	C5	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Jan	C3	0	0	0	0	1	0	0	0	1	0	0	0	0
	C4	2	1	0	0	0	0	0	2	1	0	0	1	0
	C5	1	0	0	0	0	0	0	1	0	0	1	0	0
20-Jan	C1	4	4	0	0	0	0	0	4	4	0	1	0	0
	C2	3	2	0	0	0	0	0	3	2	0	1	1	0
Total	C1	37	42	1	5	1	0	0	42	43	1	9	5	0
	C2	19	22	1	2	1	0	0	21	23	1	7	6	0
	C3	13	8	0	1	1	0	0	14	9	0	3	3	0
	C4	12	19	0	0	2	0	0	12	21	0	4	5	0
	C5	1	2	0	0	2	0	1	1	5	0	1	3	0
	Total	82	93	2	8	7	0	1	90	101	2	24	22	0

a. Included in 'Total' column.
b. Excludes 1 coho of unknown sex.
c. Excludes 1 AFC coho of unknown sex.
d. Bruised at time of release.

Appendix 8. Proportion at age and mean length at age, by location, AFC status and sex, of coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995.

		Female				Male		
Location	Mark status	Age a	Sample size	Percent	Mean POH length (cm)	Sample size	Percent	Mean POH length (cm)
Salmon River	Unmarked	4/3	0	0.0%	-	0	0.0%	-
		3/2	60	100.0%	46.8	74	100.0%	46.6
		2/2	0	0.0%	-	0	0.0%	-
		Total	87	47.8%	47.4	95	52.2%	46.8
	Adipose fin clip	4/3	1	3.0%	42.0	0	0.0%	-
		3/2	32	97.0%	46.9	30	100.0%	44.4
		2/2	0	0.0%	-	0	0.0%	-
		Total	42	50.0%	46.6	42	50.0%	45.0
	Total	4/3	1	1.1%	42.0	0	0.0%	-
		3/2	92	98.9%	46.8	104	100.0%	46.0
		2/2	0	0.0%	-	0	0.0%	-
		Total	129	48.5%	47.1	137	51.5%	46.3
Coghlan Creek	Unmarked	4/3	0	0.0%	-	2	3.6%	39.7
		3/2	60	100.0%	46.5	52	92.9%	45.9
		2/2	0	0.0%	-	2	3.6%	27.6
		Total	76	53.5%	46.3	66	46.5%	44.9
	Adipose fin clip	4/3	0	0.0%	-	0	0.0%	-
		3/2	15	100.0%	45.8	13	100.0%	45.9
		2/2	0	0.0%	-	0	0.0%	-
		Total	21	56.8%	46.6	16	43.2%	45.0
	Total	4/3	0	0.0%	-	2	2.9%	39.7
		3/2	75	100.0%	46.4	65	94.2%	45.9
		2/2	0	0.0%	-	2	2.9%	27.6
		Total	98	54.4%	46.4	82	45.6%	44.9
Total	Unmarked	4/3	0	0.0%	-	2	1.5%	39.7
		3/2	120	100.0%	46.7	126	96.9%	46.3
		2/2	0	0.0%	-	2	1.5%	27.6
		Total	163	50.3%	47.2	161	49.7%	46.0
	Adipose fin clip	4/3	1	2.1%	42.0	0	0.0%	-
		3/2	47	97.9%	46.5	43	100.0%	44.8
		2/2	0	0.0%	-	0	0.0%	-
		Total	64	52.5%	46.6	58	47.5%	44.4
	Total	4/3	1	0.6%	42.0	2	1.2%	39.7
		3/2	167	99.4%	46.6	169	97.7%	46.0
		2/2	0	0.0%	-	2	1.2%	27.6
		Total	228	51.0%	47.0	219	49.0%	45.6

a. Totals include unageable samples. b. Includes one with unknown adipose status.

Appendix 9. AFC and CWT sampling of coho salmon recovered on the Salmon River system spawning grounds, 1994-1995.

			Recovered in Salmon River				Recovered in Coghlan Creek				Total	
			Adult male	Adult female	Adult total	Jack	Adult male	Adult female	Adult total	Jack	Adult total	Jack
Sample size			146	142	292 a	1	85	101	188 b	2	480	3
Number with AFC's			44	48	92	0	24	22	47 c	0	139	0
- AFC but no head			7	8	15	0	10	2	13 c	0	28	0
- CWT lost during processing			0	1	1	0	0	0	0	0	1	0
- AFC but no CWT present			4	9	13	0	0	3	3	0	16	0
- CWT recovered:												
Code	*Brood*	*Release site*										
18 06 46	1991	Coghlan Creek	5	6	11	0	11	14	25	0	36	0
18 06 47	1991	Salmon River	24	20	44	0	3	3	6	0	50	0
18 06 48	1991	Salmon River	4	4	8	0	0	0	0	0	8	0
Total			33	30	63	0	14	17	31	0	94	0
AFC incidence (%)			30.1%	33.8%	31.5%	-	28.2%	21.8%	25.0%	0.0%	29.0%	0.0%
CWT loss (%)			10.8%	22.5%	16.9%	-	0.0%	15.0%	8.8%	-	14.4%	-
Adjusted CWT loss (%) d			3.7%	12.5%	7.8%	-	0.0%	9.1%	5.0%	-	7.0%	-

a. Includes four of unknown sex.
b. Includes two of unknown sex.
c. Includes one of unknown sex.
d. See Results, Coded Wire Tag Recoveries section.

Appendix 10. Incidence of CWT loss, by carcass condition, eye status, and AFC condition, in AFC coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995.

Observation	Condition	Number of AFC carcasses	Status unknown a	CWT absent	CWT loss
Carcass condition	Fresh	35	1	2	5.9%
	Moderately fresh	41	6	3	8.6%
	Moderately rotten	39	3	8	22.2%
	Rotten	24	20	3	75.0%
	Not recorded	0	0	0	-
Eyes	Both present	87	3	13	15.5%
	One or both absent	33	9	3	12.5%
	Not recorded	19	18	0	0.0%
Adipose fin clip	Complete	97	12	9	10.6%
	Partial	19	1	5	27.8%
	Questionable	3	0	1	33.3%
	Not recorded	20	17	1	33.3%

a. Either a carcass with no head or the head was lost during processing.

Appendix 11. Spawning success in female coho carcasses recovered on the Salmon River system spawning grounds, 1994-1995.

Mark status		Percent spawned 0%	50%	100%	Weighted mean
Disk tag or secondary mark	Number	0	0	15	
	Percent	0.0%	0.0%	100.0%	100.0%
Unmarked	Number	7	4	202	
	Percent	3.3%	1.9%	94.8%	95.8%
Total	Number	7	4	217	
	Percent	3.1%	1.8%	95.2%	96.1%

Appendix 12. Estimated coded wire tag (CWT) catch recovery of 1991 brood year coho in 1994 (only), from CWT'd coho smolts released in the Salmon River Langley system. [a]

Fishery	Location	Estimated catch in 1994								
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Sport	Georgia Str.,North			143	24					167
	Georgia Str.,South	6	3	6	5			6		26
	Juan de Fuca					2	30			32
	West Coast Vancouver Isld.			11	5		11			27
Troll	Georgia Str.				54	3				57
	Northwest Vancouver Isld.				28	13	7			48
	Southwest Vancouver Isld.				389	78	83			550
Net	Fraser River							7	11	18
	Georgia Str.					2				2
	Juan de Fuca					66				66
	Johnstone Str.					3	3			6
All	All	6	3	160	505	167	134	13	11	999

[a] The estimated total catch recoveries (in parentheses) were from CWT release codes 18-06-46 (376), 18-06-47 (555) and 18-06-48 (68)